

INSTANT MESSAGING AND TEAM PERFORMANCE IN A SIMULATED COMMAND AND CONTROL ENVIRONMENT

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Collaboration Technologies and Command and Control (C2)



- **Recent military acquisitions emphasize introducing collaboration technologies into C2 environments (Kaufman, 2005)**
- **Personnel are expected to rapidly coalesce into functioning teams (Boiney, 2005)**
- **Performance may be facilitated through emerging collaborative technologies (i.e., email, IM, virtual whiteboards, videoconferencing, etc.) (e.g., Alberts & Hayes, 2003)**



Potential Problems with Collaboration Technologies



- **Bordia (1997): Literature synthesis**
- **Baltes et al. (2002): Meta-analysis**
- **Concluded that teams restricted to text-based collaboration technologies:**
 - **Made poorer decisions**
 - **Took more time to reach a decision**
 - **Experienced less satisfaction with team processes**
 - **Pattern of results was observed across different experimental tasks**
 - **Bordia (1997): Restricted communication impairs team comprehension**



Task Type and Collaboration Technologies



- Using McGrath's (1984) circumplex model, team experiments can be categorized by *task type*
- Studies reviewed by Bordia (1997) & Baltes et al. (2002) are primarily *choosing* tasks
 - Require problem solving in situations with and without correct answers
 - Generally, task is completed when the team achieves a consensus



Task Type and Collaboration Technologies



- **C2 tasks are better described as *execution* tasks (McGrath, 1984)**
 - **Involve competition (both inter- and intra-team) or performance measured against a standard of excellence**
 - **Team performance dependent upon in-team performance and opposing-team performance**
 - **Generally, task completion criterion are different**



Goals and Hypotheses



- **Goal for the study was to evaluate the potential utility of instant messaging (IM) and to examine its effects on team performance in an *execution* task (RoboFlag)**
- **Hypotheses:**
 - **Communication restricted to IM would result in lower mission success rates, longer mission completion times, and less coordinated team strategies**
 - **Restricted communication would result in higher workload and lower situational awareness**
 - **Teams restricted to IM would send more instant messages than teams whose communication was unrestricted**



Method



- **Participants**
 - 36 paid participants (28 men, 8 women)
 - Participants completed experiment in groups of four, yielding a total of nine experimental groups
- **Experimental design**
 - 2 × 3 within-subjects design
 - Control environment (remote, co-located)
 - Level of abstraction (manual, automated, mixed)*



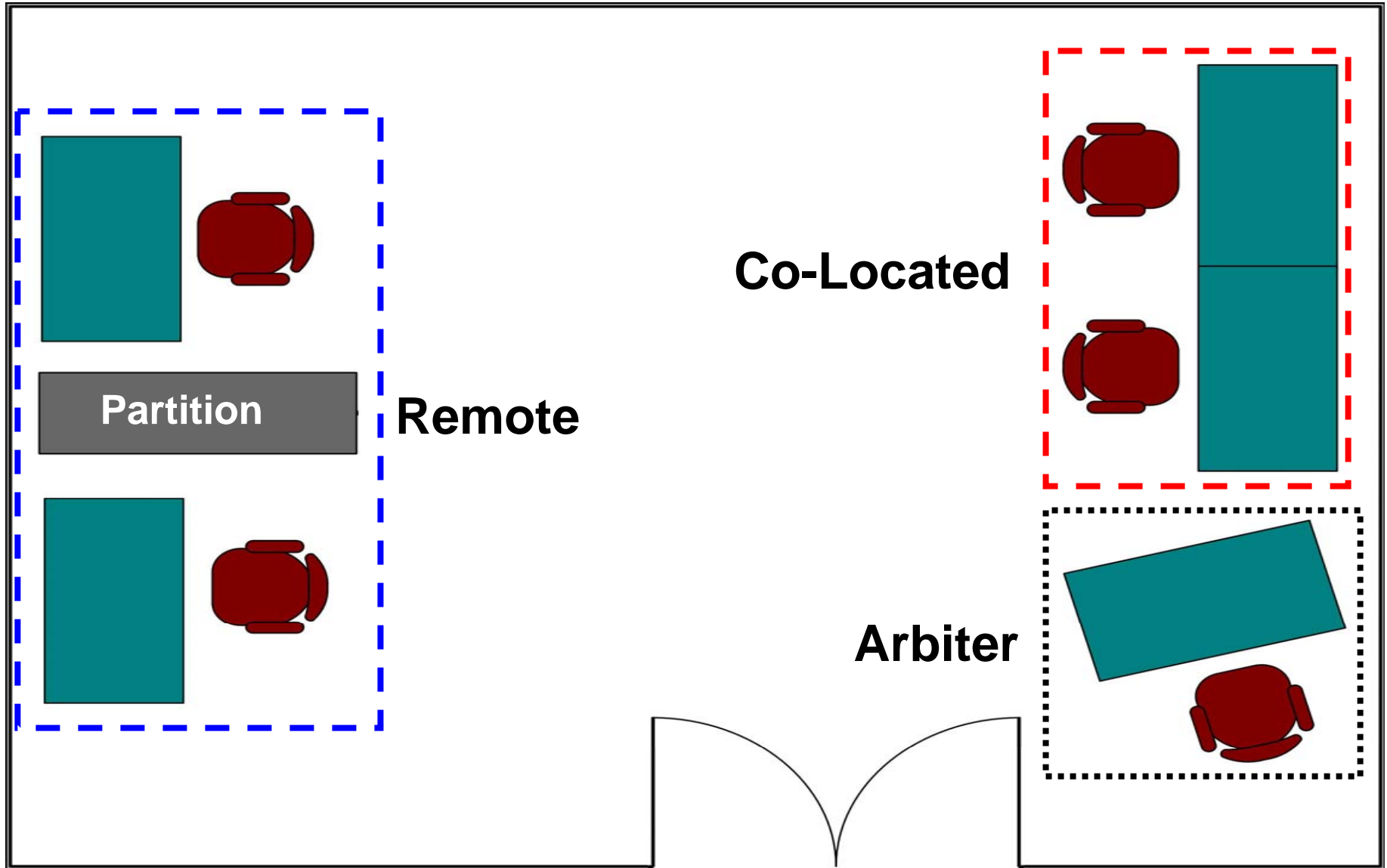
Method



- **Participants completed six mission trials in each condition (36 trials total).**
- **Control environment was a block factor (12 trials per block), and level of abstraction was randomized within each block.**
- **Participants filled out the NASA-TLX and one item from the 3-D SART following each mission trial.**

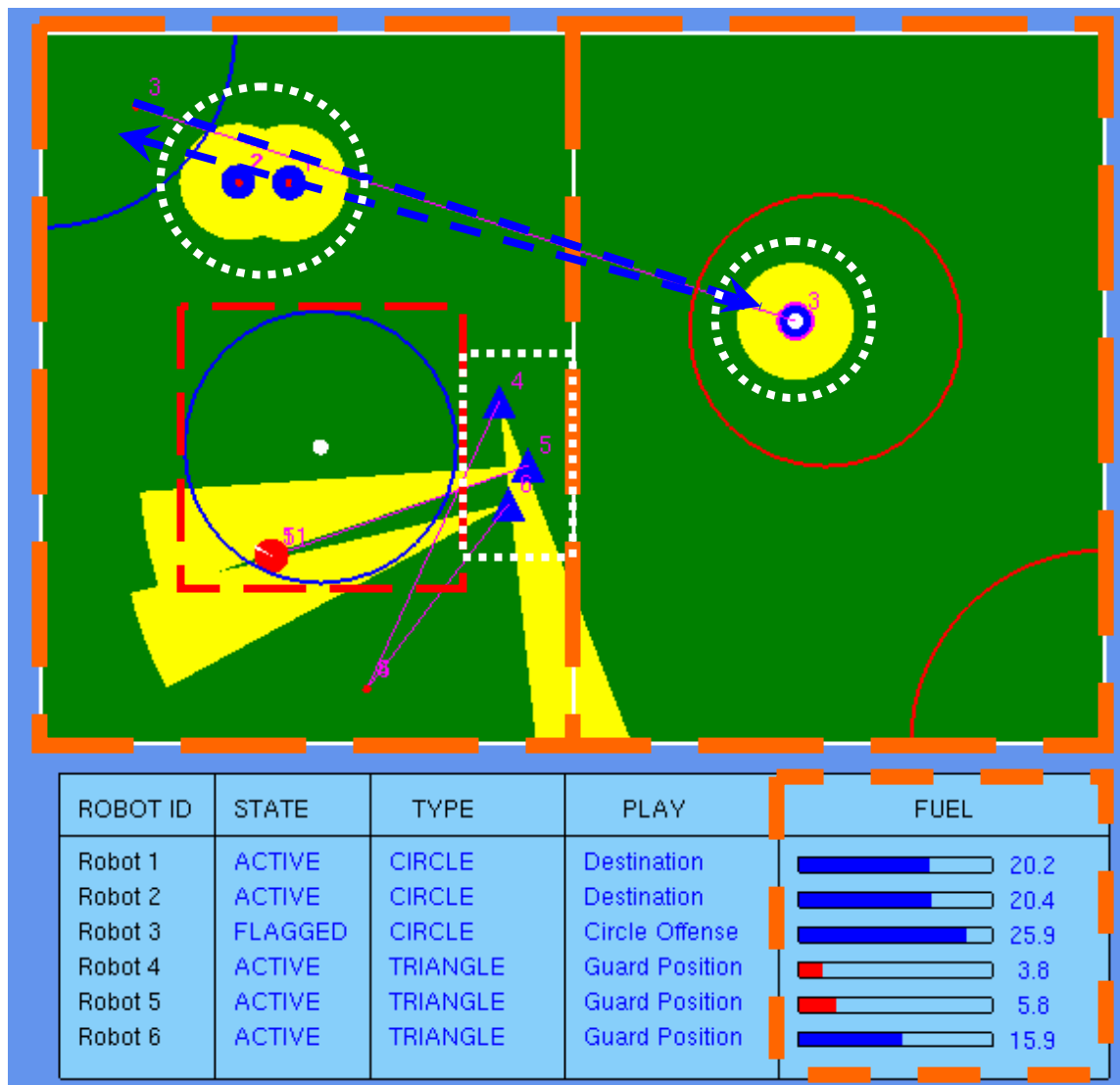


Control Environment





RoboFlag Simulated Environment





Method



- **Participants given written and verbal instructions on the capabilities of circles & triangles**
- **Participants told that experiment involved a game similar to ‘capture the flag’**
 - **Each team was in direct competition with the other**
- **Any single trial continued until one team successfully captured the other team’s flag**



Method



- **Participants allowed to practice for five minutes**
 - **Option of additional practice time if needed**
- **Prior to the start of each mission trial, participants were allotted 30 seconds for communication (30 second “huddle”)**



Results



- **RoboFlag software recorded which team successfully captured the flag (the winner) and the time elapsed during each mission trial.**
 - **Also recorded the number of vehicle position changes initiated by each participant**
- **Analysis strategy: Follow the Winner**



Results



- Data for each factor tested for statistical significance by means of a 2 (control environment) × 3 (level of abstraction) repeated measures analysis of variance (ANOVA)
- For the frequency of wins, mission length, and number of vehicle position changes no statistically significant differences were detected between the two conditions ($F[1, 8] = 0.22, 0.49, 0.45$ respectively, $p > .05$).



Results



- One possible explanation for the results was that one team consistently won all mission trials (i.e., teams were unevenly matched – team 1 vs. team 2 distinction).
- The number of mission trials each team won was counted and compared by means of a two-sample t -test.
- Result indicated that there was not a significant difference for number of wins, $t(16) = 0.73, p > .05$.



Results



- Data were also examined to identify patterns of wins that were not due to the experimentally manipulated factors.
 - Defined a win ‘streak’ as three or more serial wins by the same team
 - A total of 38 win streaks were identified in the data
 - Mean number of win streaks per experimental session per team was 2.11 ($SE = 0.32$)
 - Mean number of trials in a streak was 4.05 ($SE = 0.45$)
 - Neither was statistically significantly different



Results



- Tested the effects of the experimental conditions on participants' workload and situational awareness ratings by means of a 2 (control environment) \times 3 (level of abstraction) repeated measures ANOVA.
- For workload and situational awareness, no statistically significant differences were detected between the remote and co-located conditions ($F[1, 35] = 0.30, 0.00$ respectively, $p > .05$).



Results



- From IM logs, total number of communications per experimental session was calculated.
- Messages were divided into three categories, depending on when they were sent:
 - Pre-game messages
 - In-game messages
 - Post-game messages



Results



- IM's sent between teammates were analyzed to determine content.
- Messages were coded as either 'irrelevant' (e.g., "I'm hungry," "I like this game") or 'strategy-relevant' (e.g., "go straight for their flag," "use more robots next time").
- Two coders separately classified each instant message into one of the two categories.
 - Inter-coder reliability was good ($Kappa = 0.92$).



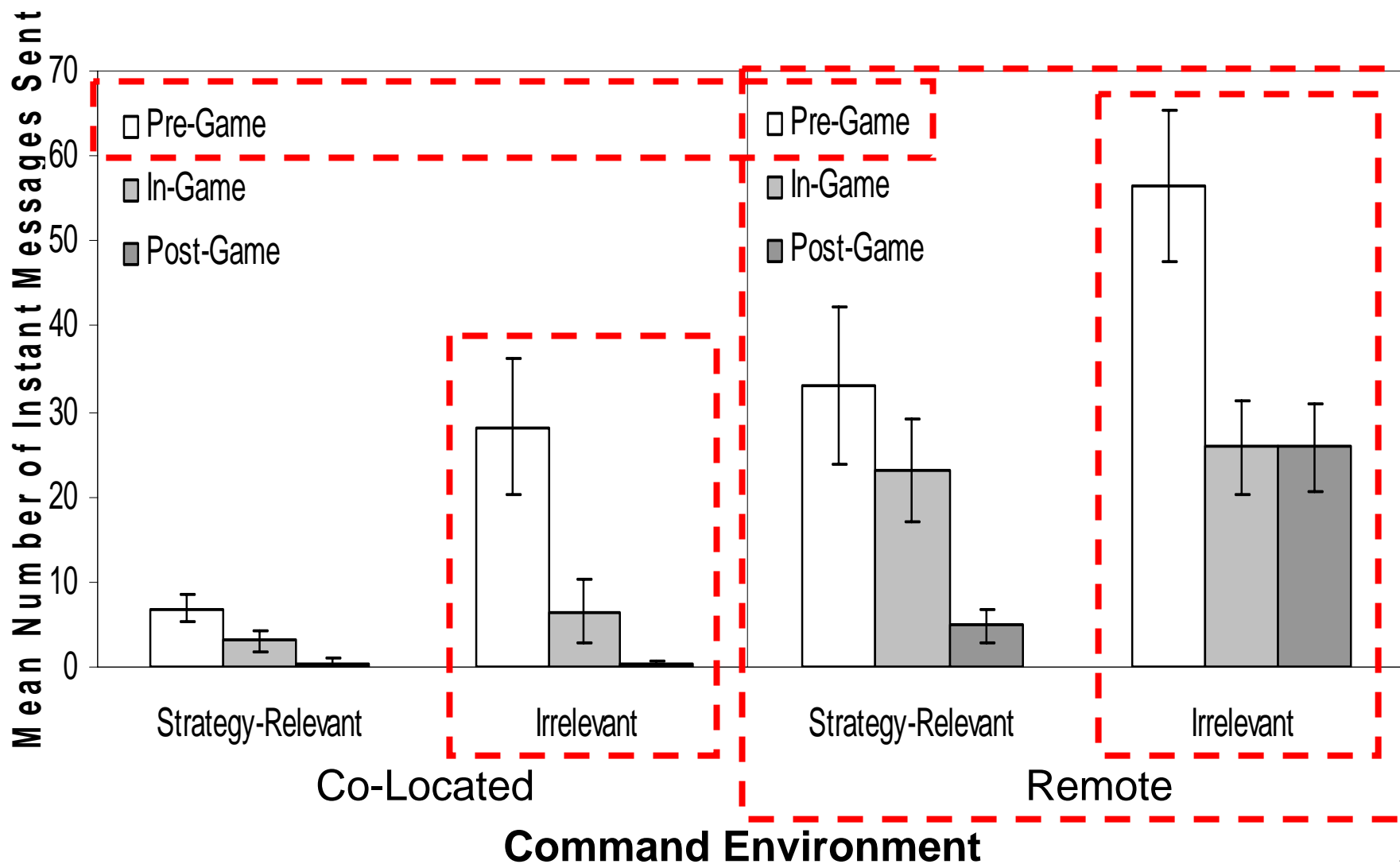
Results



- **Mean number of strategy-relevant and irrelevant instant messages sent during each messaging period for both command environments were compared using a 2 (type of message) \times 3 (messaging period) \times 2 (command environment) repeated measures ANOVA.**



Results





Discussion



- **Previously hypothesized that:**
 - ~~– Communication restricted to IM would result in lower mission success rates, longer mission completion times, and less coordinated team strategies~~
 - ~~– Restricted communication would result in higher workload and lower situational awareness~~
 - ✓ – Teams restricted to IM would send more instant messages than teams whose communication was unrestricted



Discussion



- Overall, IM did not affect team performance.
- Contrasts the effects of collaboration technologies reported by Bordia (1997) and Baltes et al. (2002)
- Dynamic, adversarial nature of execution tasks may favor:
 - Succinct messages between teammates
 - Weak or generalized strategies
 - Feedback may engender dynamic strategy evolution
 - Supported by infrequent win streaks
 - May explain high ratio of irrelevant to strategy-relevant messages



Discussion



- **IM also did not negatively impact workload and situational awareness**
 - **Temporal demands favor short communications and focused attention**
 - **Also, competition and game-related nature of the RoboFlag environment may motivate participation (Matthews & Westerman, 1994)**



Discussion



- **Participants *were* using IM for collaboration**
- **However, participants largely used IM for socialization purposes, rather than using it exclusively for strategy development and coordination.**
- **May be some concern on longer tasks, particularly if they require less active involvement**
 - **Potential for personnel to engage in off-task conversations more frequently, resulting in distraction, decreased situational awareness, and ultimately poor team performance.**



Discussion



- **Current experiment offers limited support for future successful integration of collaboration technologies into command and control environments**
- **Team performance unchanged under both command environments, indicating that IM was at least as effective as face-to-face collaboration**
- **Results underscore need for continued research into team performance and collaboration technologies in tasks from the executing quadrant of McGrath's (1984) circumplex model**



Discussion



- **Potential foci for future research:**
 - **Track strategy development, implementation, and execution**
 - **Factors that mediate the use and performance consequences of collaborative tools (i.e., task workload, time on task, etc.)**



Questions?